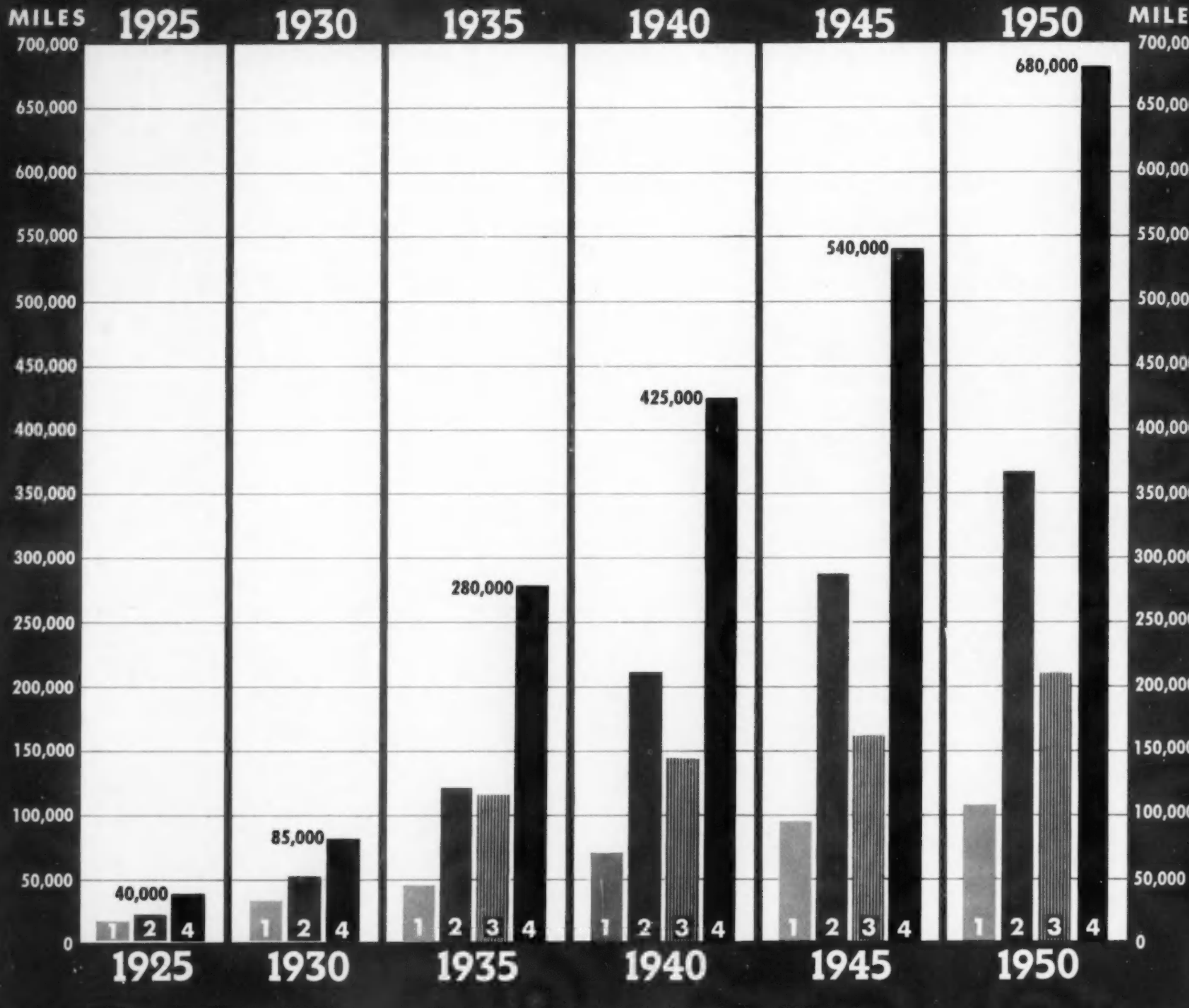
# Quarterly

# 25-YEAR GROWTH OF BITUMINOUS ROAD AND STREET MILEAGE IN THE UNITED STATES

(Existing Bituminous Mileage as of January 1st of Each Year Shown)




## KEY

1 RURAL BITUMINOUS MILEAGE — HIGH TYPES

2 RURAL BITUMINOUS MILEAGE — LOW-COST TYPES

3 URBAN BITUMINOUS MILEAGE — PAVED CITY STREETS

4 TOTAL U. S. BITUMINOUS MILEAGE (Cols. 1 + 2 + 3)

**SOURCES**—Figures used for Rural Roads are from the Highway Education Board, State Highway Officials Reports, and the U. S. Bureau of Public Roads Mileage Tables. Figures for City Streets are estimated, based on an Asphalt Institute Census for 1935 and rate of growth in key cities in subsequent years.

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## COVER

Featured on the double-cover, with a view of the Pacific Ocean, is the asphaltic-concrete highway along the California coastline, U. S. 101, between Santa Barbara and Summerland. The heavy-duty shoulders shown, seven to eight feet wide and having a seven percent slope, are surfaced with three inches of asphalt plant-mix pavement.

This graphic chart shows bituminous mileage growth, reaching a cumulative total of 680,000 miles in the most recent complete figures available. This represents over 85% of the paved mileage in the United States. For the latest single year reported, the bituminous proportion is over 90%.

# EDITORIAL

"Soft Shoulders" and "Do Not Park on Pavement." — These contradictory signs are familiar indeed to every motor vehicle operator. The first is hardly likely to encourage compliance with the second, although over and over again such warnings are to be found on the same highway within a short distance of each other. It is perhaps with not-unwarranted exasperation that the motorist inquires just what he is supposed to do under these circumstances: accept the hazard of bogging down in the soft shoulder, or remain on the pavement and risk accident to himself and others. With increasing traffic this condition however, is now so widespread that the remedy goes far beyond placement of a few warning signs.

In 1950, the nation's car drivers who "Drove Off The Roadway," as reported in The Travelers Insurance Companies' "Lucky You," injured 35,090 persons. In 1951, they increased this by 50% with an injury total for the latter year of 52,490 and also increased fatalities. Most careful appraisal of this situation and immediate correction are very much in order.

It is easy to say that the only real remedy is to build new highways, but such a development of course is possible only in limited degree. The alternative then, must be improvement of the ones already in use. "Care of Shoulders" has been one of the most costly items of maintenance, but the expenditures required vary greatly according to the kind of pavement and its width as related to traffic. If the pavement is less than 20 feet wide and traffic volume exceeds 1,000 vehicles a day, maintenance of earth shoulders in a smooth condition will require continuous attention if a rut is to be prevented immediately adjacent thereto. Even with gravel or other granular material, the over-run of traffic is so frequent that potholes develop, and almost continuous blading is required. Loose material is carried over the pavement in such operations and adds a further hazard as traffic tries to remain away from the pavement edge, to say nothing of new material required to replace that washed or worn away.

With narrow rigid pavements there is sharp contrast in supporting power at the pavement edge due to entry of water at the joint, which leads to reduced support, while in all types of pavement the subgrade is softened and edge failures become progressive. Under such conditions there is only one satisfactory procedure and that is to build a new shoulder which is as strong as the pavement itself. This will be more effective from a safety angle and the reduction in cost of maintaining shoulders on the narrow pavement will go a long way toward paying for the improvement. Every possible use should be made of local materials especially in the foundation courses. These foundations also must be strong and well drained, as this widened area will carry the heaviest trucks.

Such widening usually will take care of moving traffic needs, but there still remains the requirement for temporary parking. Here the repetition of load is infrequent, but nevertheless the shoulder should be sufficiently firm to meet the needs according to traffic and climatic conditions. Usually this can be assured by some form of bituminous construction. For light traffic roads this may require only a simple surface treatment which will hold the shoulder in place; but for heavy duty highways, a substantial structure is needed, especially where heavy trucks are in operation. Already on some of the new dual highways, inadequate light shoulders have deteriorated under severe use. A shoulder is just as much part of a proper highway design as the pavement and its width and thickness should be in proper relation thereto.

# ADEQUATE HIGHWAY SHOULDERS PROVIDE SERVICE AND SAFETY

*By [illegible], Chief Engineer, The Asphalt Institute*

**CALIFORNIA — Four-lane, divided, asphaltic-concrete free-way, approaching San Luis Obispo from the north. The above highway shoulders consist of a stone base, surfaced with a plant-mix asphalt, and an asphalt seal, using light-colored aggregate.**
*Courtesy: California Division of Highways*

It has been said that the highway shoulder is one of the most important parts of the roadway, yet it often receives the least attention. The above statement may not be generally true, but in any event this section of the highway has been receiving much more consideration in late years than in the past.

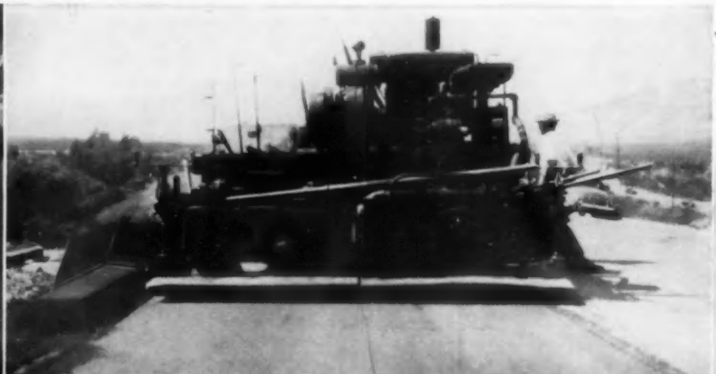
For many years the roadside areas were regarded as a necessary evil which had to be included in highway design in some manner but had only slight value as a part of the highway. Probably the main function of shoulders in early day design was to allow "shy-room". This type of shoulder was built from 1 to 3 feet in width, and provided the highway traveler with a safety clearance strip between bridge abutments or roadside ditches and the highway. Some unusual purposes were advanced at that time for shoulder use, for example, an eminent road authority in discussing highway widths prior to 1918, stated that country roads in exceptional instances could have a single track width of 7 to 9 feet, provided the shoulders were improved to accommodate passing traffic.

Today, with the heavy traffic volumes and high speeds, the function of the highway shoulder has entirely changed. To properly serve high volume traffic, it is necessary that disabled or parked vehicles be entirely clear of the traveled section of the roadway. In addition, a traffic lane will accommodate considerably more traffic when a margin of safety has been provided between the traveled roadway and side obstructions by allowing adequate shoulder width.

For example, the Practical Capacity of a 12-foot traffic lane, with 6-foot clearance between bordering obstructions and the driving pavement edge, is rated *60% greater* than that of a 10-foot traffic lane with zero clearance from the pavement edge. In addition, there is of course the added feature of *greater safety* when adequate shoulder widths are used. A further need for shoulder paving can be noted in the fact that a rating of driving habits shows that 11 per cent of the truck drivers and 5 percent of the drivers of passenger cars fail to keep their vehicles in the traffic lane when meeting on-coming traffic on narrow driving roadways.

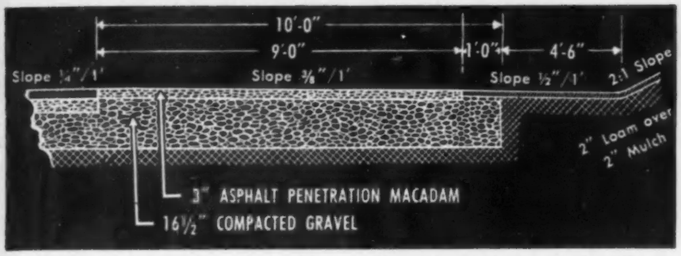
## A DRAINAGE AID

The highway shoulder lying between the pavement edge and the highway ditch also serves as an important part of the drainage system. If the shoulder base and subbase are constructed of pervious material, under-pavement drainage will be freely conducted to the highway ditch. For this reason, most states construct shoulders of a *free-draining* material. In addition, a paved shoulder serves to complete the "roof" over the roadway section and provides quick run-off for surface drainage into the ditch section. Where free drainage soils are not used in shoulder construction, some system

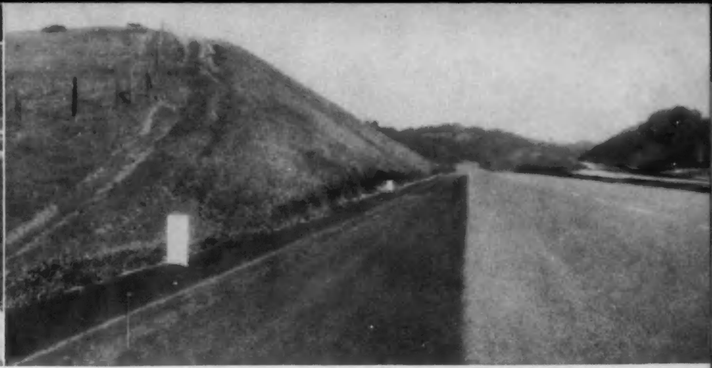


**Two detail views of a State Highway project in Santa Barbara County, California, on Route 2-G. Picture at left shows spreading of plant-mix for the eight-foot shoulder and ditch in one operation by use of attachment to the finishing machine. Picture at right shows single-operation spreading of eight-foot shoulder and curb.**

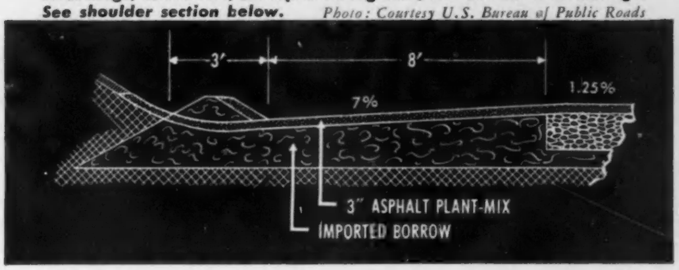
**Four-lane, divided, asphaltic concrete Route No. 128 in Massachusetts, —"The Circumferential Highway". The ten-foot shoulders are of asphalt penetration macadam, as are all acceleration lanes, deceleration lanes and accesses. See *Typical shoulder section below.*** *Photo: Howard*




**Outline cross-section of shoulder on Massachusetts' new U. S. 128.**



**State highway project in California, Monterey County Route 2-J.B. Two types of seal coat are used to show demarcation between shoulder and traffic lanes: to the right, liquid asphalt with light-colored stone screenings; to the left, an asphaltic fog coat, without stone screenings. See *shoulder section below.*** *Photo: Courtesy U.S. Bureau of Public Roads*




**Outline cross-section of shoulder on Monterey County Route 2-J.B.**

of lateral drains is normally used to care for the sub-draining. Where drains of this type are used it is also advisable to pave the shoulders, in order to waterproof this portion of the roadway and prevent infiltration of the surface water into the grade.

## LOWER MAINTENANCE COSTS

Roadside maintenance, a never ending expense, can be much reduced by surfacing the shoulder section of the highway. In many States maintenance funds are quite limited, with the result that the roadsides soon become unsightly and sometimes dangerous from rutted and muddy shoulders. Many highway officials are finding that the money spent for proper shoulder construction and paving is more than saved by reduced maintenance costs.

Except in mountainous and some special areas where provision for wide shoulders is not feasible, adequate widths 8 to 10 feet clear of all obstructions should be provided on highways on which the traffic density is more than 100 vehicles per hour. On lighter traffic roads a shoulder width of 6 feet is desirable. In rough topography the shoulder width may have to be narrowed to a minimum of 4 feet where there is heavy grading.

## CONSTRUCTION FUNDAMENTALS

Shoulders should be stable in all weather, as smooth firm sections aid in the full utilization of the pavement. For this reason, many states have found it desirable to provide an *asphalt-surfaced* shoulder and in some cases have extended the shoulder paving to include the drainage ditch section to eliminate ditch maintenance. Although a lower type of asphalt surfacing than that used for the traffic lanes can be used on shoulder surfacing, it is quite important that the *same degree of care* be exercised in this paving construction as is used on any other part of the highway. Too often the shoulders are the last part of the highway construction and, if the highway is opened too soon to traffic, or if construction is being completed in the late Fall months, the highway shoulder although adequately designed may suffer from inadequate construction.

Where traffic lanes are paved with asphalt, it is often advisable to use a light colored stone seal on the shoulder pavement to delineate the edge of the traffic lane. The contrasting colors, resulting from this method of construction, aid the night driver and provide additional highway safety.

## SHOULDER PAVING TYPES

There are four common types of asphalt shoulder paving: (1) Single or double surface treatments, (2) Mixed-in-place surfacing, (3) Penetration macadam paving, and (4) Hot-mix paving. Under any of these types, it is necessary to have a well-constructed and stabilized base which will accommodate the traffic load to be imposed on it. This is particularly true with the light surface treatments where little or no supporting value can be obtained from the type of surfacing alone. A thorough analysis of the traffic loading to be expected on the shoulders should be made and an adequate design for that load should be provided. A hurry-up job or poor construction of shoulder areas should be guarded against, since minimum thickness type design is normally used and, if improperly constructed, a failure of the roadside area will follow with resulting high maintenance costs and inadequate shoulder areas.

To sum up, *if economically possible,* shoulders should be paved to:

1. Provide for the safe and maximum use of the traffic lanes.
2. Serve as a necessary and important adjunct to the drainage system.
3. Eliminate unsightly areas along the driving lanes and provide a hard surfaced area for parking.
4. Reduce roadside maintenance to a minimum.

With the ever-increasing traffic of today, it is necessary for all highway agencies to utilize to the utmost any method which may increase highway service at a minimum cost. Certainly, the proper construction and paving of highway shoulders is a method which warrants most complete investigation for furthering greater highway design efficiency.

# ASPHALT SHOULDER CONSTRUCTION IN CALIFORNIA

*By Alfred L. Ryan, District Engineer, The Asphalt Institute*

**Fresno County, Route 10-A. This picture shows shoulder and dike construction. The material was local borrow, treated with a liquid asphalt to a depth of 4", using 0.85 gallon S.C.3 per square yard per inch of depth.** *Courtesy: California Division of Highways*

The need for shoulder construction adjacent to our paved highways has been apparent for many years. In the early days of motor transporation, with traffic light and speeds comparatively slow, the automobile was subject to frequent mechanical and tire troubles. An area was needed adjacent to the traffic lane then on which an automobile could park for tire changes or be pushed, if disabled, without sinking up to its hubs in mud. Shoulders still serve this original purpose but, with modern traffic and high speeds, they also provide maneuvering room in an emergency. Still another function is to provide edge of pavement support.

We see, then, that shoulders are directly tied in with traffic safety. To carry out this safety function the shoulder must be usable in foul weather as well as fair. A soft, soggy shoulder becomes a hazard when signs reading "Soft Shoulders" cause traffic to veer closer either to the center line or adjacent traffic lane. While it is not the intent to encourage traveling on the shoulder, its condition should be such that a vehicle could swerve onto it when necessary to avert a possible accident.

The construction of untreated shoulders in California has diminished almost to the vanishing point; on *primary* highways the practice has long since been completely discontinued. The type of asphalt construction used varies from an asphalt surface treatment, mostly in light traffic rural areas, to shoulders paved with asphalt plant-mix.

## NEW CONSTRUCTION

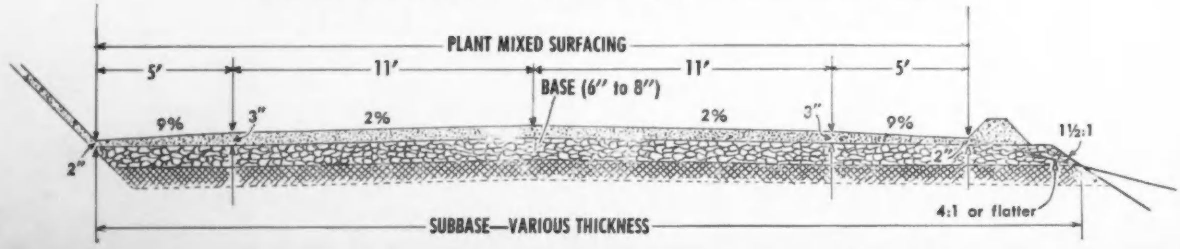
Whether the construction is to be rural two-lane, rural divided multi-lane or urban divided multi-lane, controls the width of the shoulder to be built. At present, for rural two-lane, extensive use is being made of an "all-paved section" which carries the traveled-way base and surfacing to the outer edge of a four or five foot shoulder, resulting in an all-paved section 30′ to 34′ wide. The shoulder width may, when desired, be set off from the traffic lanes by use of an appropriate seal coat differing in surface texture from the seal coat used on the traffic lanes.

For rural divided multi-lane highways, past practice has been to construct an 8′ shoulder to the right of each traveled-way, the first 3′ paved with plant-mix plus 5′ of penetration treatment. Present practice, however, is to pave the entire 8′. On the left, for an uncurbed median, 5′ shoulders are constructed consisting of a 2′ paved border plus 3′ of penetration treatment. The 5′ shoulders on the left are intended for pavement edge support and additional maneuvering room only. Parking in the median should be discouraged.

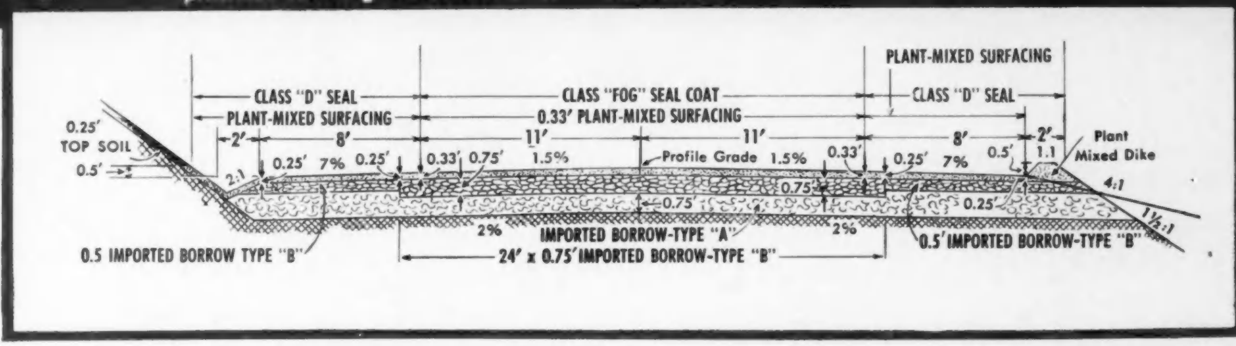
For urban divided highways and freeways 8′ shoulders are constructed on the right, the first 5′ of which are asphalt paved, the remainder being a rolled curb and gutter section. If there is no curb and gutter in the median and the median is of sufficient width shoulders are constructed just as for rural divided multi-lane highways. Shoulders on the Interstate System are usually paved 8′ full width.

For new construction of light-traffic roads, shoulders may vary in width from 4′ to 10′. For both new construction and widening of old construction, there have been many miles of ditches paved and shoulder dikes constructed. This work is accomplished with plant-mix and in many cases an 8′ shoulder plus a paved ditch or shoulder dike has been

STANDARD TWO LANE ALL PAVED TYPICAL SECTION



These pictures, together with those at the bottom of page 4 showing construction details, were made on the State Highway project, Santa Barbara County, Route 2-G. The imported borrow base was constructed with two types of material, the lower layer having a California Bearing Ratio requirement of 20 and the upper layer of 80. Both materials had a Plasticity Index requirement of not over 6. Both layers were compacted to a density of 90%, as determined by the California Field Impact Method. The liquid asphalt used in the plant-mix surfacing was S.C. 6. See cross-section below.




spread in one operation by attachments on the finishing machine.

There is still considerable mileage of existing 18' and 20' paved roads with untreated or inadequate shoulders. Many of these, due to increased traffic load also need widening, and contracts are being let to include in one operation widening, re-surfacing, and the construction of new and adequate shoulders on some of these roads. Other contracts on some of the 20' roads are for constructing paved shoulders only.

## CALIFORNIA'S DESIGN OF FLEXIBLE PAVEMENTS

The structural design of flexible pavements in California is based on determining the physical properties of the basement soils and other available materials for sub-base, base, and surface construction. The thickness of each increment varies according to its supporting power and the magnitude of the super-imposed vehicular loads. The vehicular wheel loading is expressed as the number of 5,000 pound equivalent wheel loads (E.W.L.) the pavement is expected to accommodate in the ten years following construction. On shoulders other than the all-paved sections, the shoulders are designed structurally to withstand 1% of the E.W.L. on the traveled way, but not to exceed one million E.W.L.

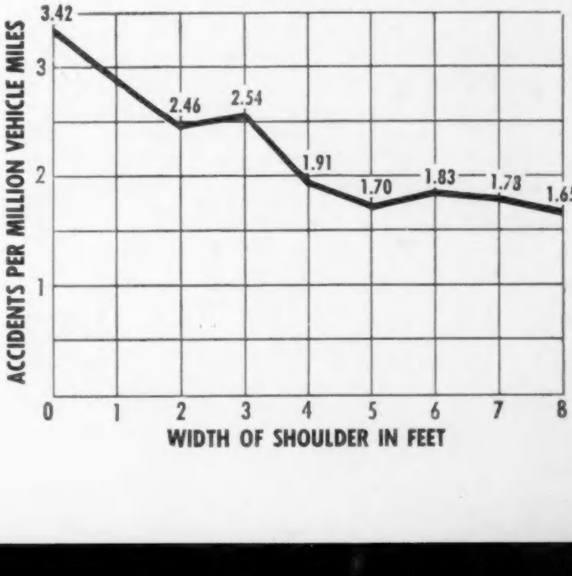
Base materials for shoulder construction are thus dependent to some extent on the structural design of the adjacent traveled way. Natural soils may be used for shoulder construction if they have a California Bearing Ratio of 50 or better and a Plasticity Index below 6-8. Where suitable natural soils are not available, imported or selected materials are used. Shoulder base material for use adjacent to 18 or 20 foot existing roads, which are subjected to fairly heavy traffic, is usually commercial rock-base or crusher-run. On

*Continued on page 8*

## WIDTH OF SHOULDER VS ACCIDENT RATE

**The California Division of Highways in 1950 published a chart containing what are still the latest figures available, showing the relationship of shoulder width to traffic accidents per million vehicle miles. The traffic check was made in 1947 and 1948 for two-lane roads only on the state's Interstate Highway System. The road mileage included totalled 1,168.61 and the vehicle mileage 1,408,012,000.**

**The following graph clearly indicates a declining accident rate.**



**US 101 BETWEEN SANTA BARBARA AND SUMMERLAND**
*Courtesy: California Division of Highways*

*continued from page 7*

light traffic highways, particularly in sparsely settled areas, poorer soils may often be road-mixed with liquid asphaltic materials to obtain a stable all weather shoulder.

Asphalt shoulder surfacing may be a surface treatment, road-mix, penetration, plant-mix or some combination of these. The selection of the pavement type is dependent on the traffic, the number of traffic lanes, and, to some extent, the local materials available. The type of asphaltic materials for surface treatments, road-mix and penetration are slow-curing oils, medium-curing oils, emulsions and, occasionally, rapid-curing oils. Either S.C. 5 or S.C. 6 has been used in plant-mix shoulder work heretofore but the tendency now is to use a paving asphalt ranging from 85-300 penetration.

The thickness of the shoulder surface may be the same as that of the roadway or it may taper to the outside edge of the shoulder. Of course, in the all-paved section the surface is of the same thickness throughout. Even with tapered shoulders it is common practice to carry full paved thickness to a foot beyond the traveled way before the tapering. This tends to take care of the meandering habits of some drivers.

*Appreciation is expressed to E. T. Telford, Engineer of Design, California Division of Highways and his Staff for much of the data used in this article.*

The picture above shows asphaltic concrete main traffic lanes, bordered by asphalt plant-mix surfaced shoulders, on Coast Route US 101, between Santa Barbara and Summerland. Pertinent construction data for this Route, which applies also to the picture shown on the covers of this Quarterly, follows:

State Highway Project No. V-S.B. 2-J.

Year constructed: 1948

Width of shoulder construction: varied 7 to 8 feet

Type: 3 inches asphalt plant-mix surfacing on Imported Borrow Class A

Thickness of borrow: Varied 12 to 21 inches

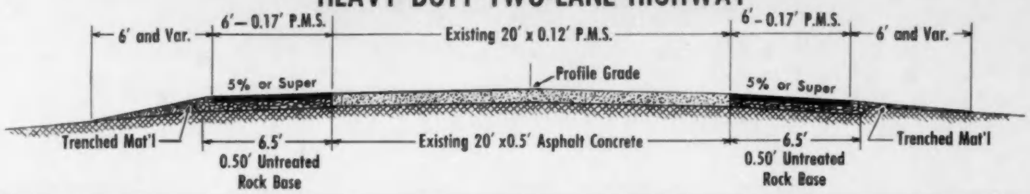
Specifications: Imported Borrow Class A

- Passing 1 and ½ inch, 100%
- Passing 200 mesh, not more than 15%
- California Bearing Ratio 60% plus
- Cementing Value 50 plus
- Expansion 1% minus
- Stability 25% plus
- Swell 0.030 inches minus

The borrow was placed on the basement soil and compacted to 90 percent density prior to placing the asphaltic plant-mix surfacing. The slope of the pavement shoulders is 7%.

# California's Current Typical Shoulder Cross-Sections

## HEAVY DUTY TWO-LANE HIGHWAY




This cross-section is for shoulder construction advertised for bid opening April 16, 1952. It is typical for shoulder construction on a fairly heavy-duty, two lane highway. The location is on U. S. 40 between Sylvan Corner and Roseville. 2" of plant mix surfacing is to be placed on 6" of untreated rock base. The specifications provide that the untreated rock base material shall conform to the following:

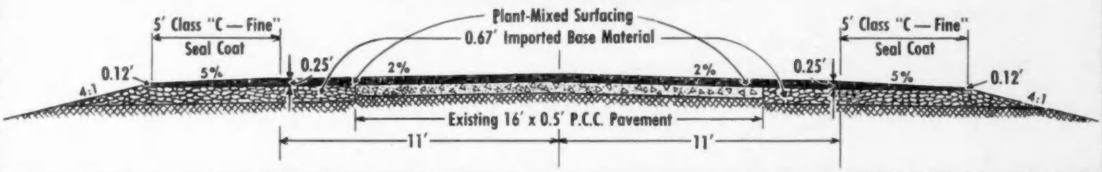
| | |
|---|---|
| Resistance Value ("R" value) | 78 min. |
| Plasticity index | 6 max. |
| Pass 2" sieve | 100% |
| Pass 3/4" sieve | 65-90 |
| Pass No. 4 sieve | 35-55 |
| Pass No. 200 sieve | 3-9 |
| Swell | 0.030 max. |

The "R" value is gradually taking the place of the California Bearing Ratio test. An "R" value of 78 is better than the old CBR of 80.

After placing the rock base it is to be penetrated with ½ gal. per sq. yd. of S.C.2 in two applications of approximately ⅛ gal. and ⅜ gal. per sq. yd. Sand shall be spread over the treated areas at the approximate rate of 15 pounds per sq. yd. before spreading the plant mix surfacing. A seal coat of ashalt emulsion is to be applied to the finished shoulder at the rate of 0.1 to 0.15 qal. per sq. yd. The emulsion used is to be a mixing type emulsion mixed with an equal volume of water.

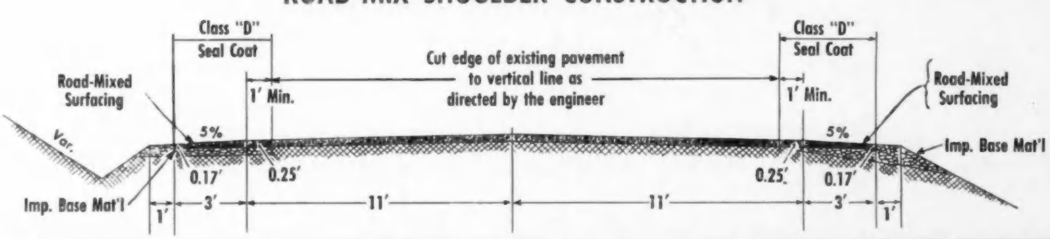
The above specification is given in such detail because it does exemplify the latest for this type of shoulder construction.

## RESURFACING, WIDENING AND SHOULDER CONSTRUCTION OVER OLD P.C.C. PAVEMENT




The above cross-section is an example of carrying the full 3" thickness of plant mix beyond the limits of an old portland cement concrete pavement to give 11' driving lanes and then tapering the remainder of the 5' shoulder to a thickness of approximately 1½".

## ROAD-MIX SHOULDER CONSTRUCTION




This cross-section illustrates a road mix shoulder construction carrying full thickness for the first foot on either side and then tapering to form a 3' shoulder.

# Surface Treatment of Shoulders by the South Carolina State Highway Department

By William H. Mills, District Engineer, The Asphalt Institute

South Carolina, U. S. 1, near Lexington. Completed surface-treated shoulder along sheet asphalt pavement.
*Photo: Mills*

In 1930 the South Carolina State Highway Department began to study methods for protecting the shoulders of its 18-foot width portland cement concrete pavements. The raised-lip concrete curb was not adopted because of its high cost and the objections of poor drainage and hazard to traffic. As an experiment, several sections of shoulders where the soil was "top-soil" material were cleared of grass and vegetation, then primed and improved with a double application asphalt surface treatment. Most of the work was 5 feet wide on each side of the pavement. These installations proved so successful in preventing erosion that the procedure was continued in a limited manner until, at the end of 1937, a total of 75 miles had been completed.

The need for protection of the shoulders against erosion by rain continued to require preventive maintenance of this type, but it was the steady increase in the volume of traffic carried by these 18 foot pavements that, by 1937, made the need for protection acute in numbers of places. At this time, the mileage of pavement in the highway system less than 20 feet wide was about 2,000, and a program to treat the shoulders on this entire mileage was begun at once.

## USE OF LOCAL MATERIALS

In South Carolina there is an abundance of friable sandy soil which, if carefully selected for proper gradation and low plasticity, is excellent material for a base course. The soil is of two types:

1. SAND-CLAY, which is a natural mixture of sand and clay occurring in the Sand Hill and Coastal Plain sections of the state at a depth usually of one to eight or ten feet below the surface. Good sand-clay soil for base course usually has at least 50 percent retained on the 60 sieve, 10 to 15 percent passing the 200 sieve, and a plasticity index below six.

2. TOP-SOIL, which occurs usually in the Piedmont area of the state, is a residual soil from which the clay has been leached over a period of years. Good soil of this type for base will usually have some coarse material retained on a No. 10 sieve, 40 to 50 percent retained on a No. 60 sieve, and 15 to 30 percent passing the No. 200 sieve. The portion passing the No. 200 sieve is high in silt and the plasticity index of the binder material is zero.

For many years it has been standard practice in South Carolina to use top-soil or sand-clay in the *shoulders* adjacent to the pavements because of their permeability for drainage, their high stability when wet, and the suitability of these materials for growing grass. For this reason, the soil in place on the shoulders was frequently satisfactory for the base course. If the existing soil is not satisfactory, it may be stabilized by one of several methods or it is excavated or pushed to the edge of the shoulder and a new base of selected soil is hauled in and compacted.

Photos: No. 1 Mills; Nos. 2 to 8 inclusive, Courtesy South Carolina State Highway Department

1—Shoulder along 18-foot pavement prior to surface treatment. Note eroded soil.

2—Dumping new base course material into excavation for shoulder treatment.

3—Applying liquid asphalt to base course material in mixed-in-place procedure.

4—Compacting base course material with sheepsfoot roller.

## CONSTRUCTION PROCEDURE

A compacted depth of 6 inches and a width of 5 feet has been adopted for the surface treated shoulders. The surface treatment is done in accordance with the standard highway specifications using the following approximate quantities per square yard: 0.3 gallon bituminous prime; 0.4 gallon 150-200 penetration asphalt; 45 pounds 1¼″ stone; 0.17 gallon liquid asphalt; 24 pounds ½″ stone; 0.17 gallon liquid asphalt. The procedure for applying the seal coat is rather unique in that about half (0.17 gal.) of the liquid asphalt is applied on top of the mat stone, the ½″ stone is spread, uniformed by brooming and rolled, and then the remainder (0.17 gal.) of the liquid asphalt is applied. This procedure reduces the cost compared with the drag seal method and it practically eliminates whip-off of the seal coat aggregate.

The shoulders are prepared for this treatment by excavating the existing soil for a depth of 3″ to 5″. Where the mixing is to be done in place, sufficient fine sand is added to the shoulders to give a compacted thickness of equal depth.

Two methods of mixing are employed. The first wherever the material in place on the shoulder is unsuitable for stabilization and it is necessary to secure suitable material elsewhere. A pug mill with a capacity of approximately 400 cubic yards per day, fed by a crane and powered by a tractor, mounted so that it can discharge directly into a truck body, is erected in a borrow pit. Approximately 15 gallons of RC cutback asphalt is mixed with one cubic yard of soil.

The second method is to mix the materials in place using graders and harrows. In this case the fine sand in the shoulder is scarified and pulverized to a uniform depth of 3″ to 5″. Rapid curing cutback asphalt is applied at the rate of about 0.75 gallon per square yard per inch of finished thickness with a pressure distributor and cut in with a harrow. Mixing is continued until the mixture is uniform. Then the mix is shaped to the required cross section. It has been found that the amount of work necessary to shape the mixed material is sufficient to permit the escape of the volatiles in the cutback. The material is compacted with loaded trucks, a pneumatic roller, or a sheepsfoot roller. Finishing is performed with a small grader having a tell-tale device mounted on the blade to obtain a correct and uniform slope. Compaction is completed during the finishing operation.

After it has been determined that the sand-asphalt base is firmly compacted, properly cured, cleaned and dried, a wearing surface is applied. This wearing surface is a single surface treatment using the following quantities per square yard: 0.38 to 0.43 gallon of 150-200 penetration hot asphalt covered with 30 to 32 lbs. per square yard of ¾″ No. 16 aggregate. The aggregate is spread uniformly over the base with mechanical spreaders mounted on trucks, and then rolled with a 5-ton roller.

## MILEAGE AND COSTS

At the end of 1939 approximately 900 miles of shoulders had been surface treated, and at the end of 1949 this total had been increased to 1,400 miles. This program of improvement, "shoulder treatment" as it is called locally, has been advanced at the rate of approximately 100 miles per year. The annual report of the Department for 1950 shows $99,500 spent for shoulder treatment during the year and the sum of $111,000 programmed to cover the cost of treating approximately 90 miles in 1951. For 1952, shoulder treatment is planned on 258 miles at an estimated cost of $292,000.

Before the war, prices were of course quite low as compared with present day costs, and in 1939 the cost of shoulder treatment including both base and asphalt surface treatment was approximately $0.35 per square yard. Present prices are estimated to be approximately as follows:

COSTS PER SQUARE YARD

| | | | |
|---|---|---|---|
| Asphalt Stabilized base | $0.55 | Top-soil or Sand-clay base | $0.15 |
| Inverted penetration surface | $0.15 | Double Bituminous surface | $0.35 |
| Total per sq. yd. | $0.70 | Total per sq. yd. | $0.50 |

Formerly most of the shoulders were treated for a width of five feet on each side, but in recent years the treatment has usually been varied from three to four feet to give an over all width of 24 feet.

## BENEFITS DERIVED

The surface treatment of shoulders by the South Carolina Highway Department is considered an outstanding accomplishment. The safety of the narrow pavement is greatly increased by this inexpensive procedure. The surface treated shoulder provides additional width of usable all-weather surface for an emergency, and normally traffic travels nearer the edge of the existing pavement because of the usable shoulder which increases the effective width of the old pavement. The hazard resulting from the erosion of soil along the edge of the old pavement is definitely eliminated. This greater safety is obtained at very low first cost which can be amortized over a period of years *by the saving in maintenance expense alone.*

An additional benefit from the shoulder treatment is that it serves as an initial stage in widening the pavement. Full value is obtained from all work in connection with shoulder treatment because, when the existing narrow pavement is re-surfaced, the asphaltic concrete is extended over part of the treated shoulder so that the finished width of the new surface is 24 feet. The treated shoulder serves as a base for this widening usually without any additional processing and the widening is thus obtained at minimum cost.

This report is made possible through the courtesy and cooperation of C. R. McMillan, Chief Highway Commissioner, S. N. Pearman, State Highway Engineer, W. K. Beckham, Maintenance Engineer, and J. K. Crowson, Secretary-Treasurer of the South Carolina State Highway Department. Much of the data were obtained from a paper "Shoulder Treatment in South Carolina" by S. J. Mathis, former Assistant to Maintenance Engineer.



5—Finished shoulder base course ready for surface-treatment. Paper protects pavement edge.

6—Applying 150 to 200 penetration asphalt.

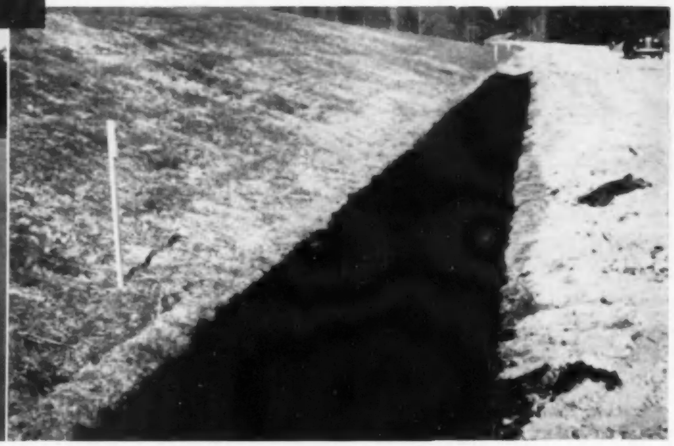
7—Applying coarse aggregate.

8—Rolling is an essential part of the construction.

# SURFACE DRAINAGE STRUCTURES

By George W. Dent, District Engineer,
The Asphalt Institute

**There are several general methods of pavings ditches, gutters, interceptor drains, berms, and flumes that have proven particularly effective, the least expensive method being surface treatments. The treatment can be either a single application of asphalt and aggregate or multiples thereof. Plant-mixes, preferably hot, are more durable and the completed work presents a more pleasing appearance.**
*Photos: Courtesy U. S. Bureau of Public Roads*



**By taking full advantage of the versatility of asphalt and asphalt paving practices, the highway engineer is able to save a good many maintenance dollars that would otherwise be wasted. One of the ways is to use asphalt in building surface drainage structures to prevent soil erosion along roadways. Asphalt has also been successfully used to construct curb or rebuts to control the flow of water.** *Photo: Dent*

**In constructing asphalt curb, plant-mix should always be used. It is only necessary to set a single line of forms to construct a curb having perfect symmetry. Care should be exercised in designing the curb to see that the face is on a sufficiently flat slope to prevent distortion. The asphalt content should be increased slightly over that of a paving mix to lend durability.** *Photo: Dent*

Before a highway project can be called complete, the engineer must provide for many details that do not get a second glance from the traveling public. Among these are such items as curbs and gutters along some sections; or, on top of a high bank, there may be a diversion ditch that cannot even be seen from the roadway. That ditch up on the slope-top can be very important, though. It is placed there to catch water and prevent a slide that might block the highway completely. Then there is the flume or lead-off ditch that is paved to prevent water from eroding the side of the fill. All of these, which may be referred to as surface drainage structures, are necessary items that go into the make-up of most highway projects.

For the amount of material that goes into them such structures can be quite costly, yet they are so necessary to the roadway's actual existence that they must be built. We should recognize that they are indispensable and construct them in the most economical manner. The most satisfactory and efficient way to do this is through the use of asphalt. Plant mixes have been widely used in curb, gutter, flume, and ditch construction in many parts of the country. Based solely on their excellent performance, their use should be widely extended. Some asphalt gutters constructed about twenty years ago on the famous Skyline Drive in Virginia are still giving excellent service and no money has been spent in maintenance.

The building of these very necessary water courses or erosion preventives is simplicity itself. In many cases all that is necessary is to excavate to the proper dimensions and place the asphalt mix; forms are seldom required. In the case of curb, only one single line is needed. Even here forms may be eliminated as it is practicable to make a simple slip-form attachment to be fitted on the blade of a motor grader. Other more elaborate forming tools or attachments have been used in connection with the conventional asphalt pavement finisher or paver.

Asphalt used in this type of work has many advantages over other materials. The pavement can be placed thinner and with ordinary tools as an integral part of the highway construction project. The asphalt material can be placed to follow the contour of the ground when such procedure is advisable, as on a high bank. The cost is generally far less than half the amount that would be spent if other materials were used.



(Left) Main Street, [illegible] in 1922, between Court and Ch[illegible] [illegible] Paved in 1894 with [illegible] asphaltic concrete base and asphalt [illegible] face. (Right) The same location, the same pavement, in 1952—after [illegible]

# 58 Year-Old Asphalt Pavement in VISALIA, CALIFORNIA

Visalia, in California's San Joaquin Valley, is celebrating its Centennial this year, as it was designated the county seat of Tulare County in 1852. In those early days of the Forty-niners, Visalia was a busy pioneer center, the only stage-route stop between Stockton and Los Angeles. Not until 1894, however, was it decided that the traffic of the day warranted the laying of permanent pavement on its main street.

In the latter year, the Common Council of the City of Visalia adopted a "Resolution Ordering Work To Be Done", authorizing the paving of Main Street "from the east line of Garden Street west to a point seventy-five feet east of the east line of Locust Street, including all intersections of streets; said intersections being the street crossings at the intersections of Main and Garden Streets, Main and Church Streets and Main and Court Street . . ."

In this resolution, there followed exact specification requirements, too lengthy for inclusion here, under the headings, Paving, Road Bed, Foundation, and Wearing Surface. Upon the prepared road bed a five-inch asphaltic concrete foundation of asphalt cement, sand, and gravel was to serve as base for a one-inch sheet asphalt wearing course of asphalt cement, sand, and lime. In the construction the asphalt, sand and gravel were all locally available. Bid price for the paving complete was $2.23 per square yard.

## THE AUTHENTICATED RECORD

Writing under date of June 2nd 1920, L. H. Gadsby, then City Engineer of the City of Visalia, reported on this Main Street, as follows:

> The first paving of any kind laid in Visalia was a stretch of about three blocks on Main Street. This was laid in the fall of 1894, and is described in the old records as "a pavement consisting of an asphalt concrete foundation with an asphalt cement surface". It actually consists of an asphaltic concrete base about 6 inches thick, with an asphalt wearing surface a good inch in thickness. Gravel hauled in by team from the vicinity of the foothills some twenty miles away was used as aggregate in the base, and the sand was procured in this vicinity.
>
> Nothing has been expended for maintenance on this pavement, and it is in excellent condition today. We have no doubt but that this pavement is good for many future years of service, in spite of the tremendous increase of traffic in volume and especially in weight.

Writing of Acequia Street pavement in addition to Main Street, he continued:

> Both these pavements have their severest test during the summer months when the temperature runs very high. Fruit is being hauled in then to the canneries and packing houses, in trucks and trailers piled high with boxes, but these pavements stand it, and have done so for many years, with no signs of flowing, rolling, rutting or any other failure.

In 1933, Mr. Gadsby, still City Engineer, reported further that nothing had been spent for maintenance of this old Main Street pavement up to that date.

As of April 27th, 1952, Mr. Gadsby, though not now City Engineer, in writing to Bernard E. Gray, President of the Asphalt Institute, advised that he frequently drives over this pavement and finds it in good, usable condition. In regard to maintenance, he reports that about ten years ago some surfacing had been done, applying an asphalt emulsion seal.

This photograph of a [illegible] cut th[illegible] old Main Street pavement in [illegible] a well-constructed, [illegible] pavement little changed [illegible] from what [illegible] would have shown in 1894. It is [illegible] through the courtesy of [illegible] George C[illegible] City Engineer of Visalia.

CUT-SECTION SCALE RATIO: 1 TO 3

# ASPHALT INSTITUTE ENGINEERS

**GEORGE B. FINLEY**
*District Engineer at Austin*

**WILLIAM H. RHODES**
*District Engineer at New Orleans*

George B. Finley, with headquarters in the Littlefield Building at Austin, serves as a District Engineer for the Asphalt Institute, extending its engineering promotional activities throughout the southern sections of the State of Texas.

A native son, Mr. Finley has lived and worked in Texas all his life, with the exception of six years when he helped to dig the Panama Canal. After graduation from the University of Texas, his engineering career, prior to coming with the Institute in 1950, included several years in railroading, followed by twenty-three years with the Texas State Highway Department. There he served eighteen years as Division and District Engineer and five years as State Maintenance Engineer. Mr. Finley is a Texas Registered Professional Engineer.

William H. Rhodes, from his headquarters at 1531 Henry Clay Avenue at New Orleans, serves the Asphalt Institute as District Engineer throughout Louisiana and Mississippi.

A graduate of Worcester Polytechnic Institute, with an outstanding career in Highway Engineering from 1910 to 1927, with sales and management added responsibilities in Industry from 1927 to 1950, Mr. Rhodes joined the Institute staff in the latter year.

Included in Mr. Rhodes' highway engineering experience were his organizing of the Maintenance Engineering Highway Department of Louisiana in 1922 and a similar organizing in 1924 for the newly-created State Highway Department of Oklahoma. Mr. Rhodes is a Louisiana Registered Professional Engineer.

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